17. (Amended) A decoding device for demodulating a received signal available in serial code concatenation in a code-division multiple access transmission system, a two-step coding being carried out at the transmitting end of the transmission system, the device comprising:

a soft-in/soft-out decoder disposed in a receiver of the transmission system, a first decoder step of the soft-in/soft-out decoder including an inner decoder and a Hadamard orthogonal multi-step inner code, a second decoder step of the soft-in/soft-out decoder including an outer decoder and an outer error-correctinge code of a predefined rate, soft values being processed as reliability information at an output and an input of the soft-in/soft-out decoder, a soft output of the inner decoder being a soft input for the outer decoder, a channel reliability information output from a preceding demodulation being an input for the inner decoder.

REMARKS

Claims 1 to 24 are pending in the above-identified application. Claims 1, 10 to 15 and 17, have been amended above. No new matter has been added. Changes in the claims are shown on the attached "Amended Version Showing Changes Made" in which any deleted text is square-bracketed and added text is underlined.

Applicants thank the Examiner for accepting the informal drawings for examination purposes. Applicants will submit formal drawings upon allowance.

Claims 1 and 17 were objected to for an informality in the preamble. Claims 1 and 17 have been rewritten above in accordance with the Examiner's suggested clarifying language. Accordingly, withdrawal of the objection to claims 1 and 17 is respectfully requested. Applicants respectfully submit that now rewritten claims 1 and 17 are in condition for allowance.

Claims 10 to 15 were rejected under 35 U.S.C. § 112, second paragraph, as indefinite. Claims 10 to 15 have been rewritten above to include a definition of the term "u." Claims 12 and 13 have been rewritten above to include a definition of the term "y." Claim 14 as written already included a definition of vector 7. Accordingly, withdrawal of the rejection to claims 10 to 15 is respectfully requested. Applicants respectfully submit that now rewritten claims 10 to 15 are in condition for allowance.

Claim 34 was rejected under 35 U.S.C. § 112, second paragraph, as indefinite, for being dependent on claim 28. Applicants respectfully submit that there are no pending claims 34 and 28 in the above identified application. Accordingly, such rejection is moot.

Claims 1 to 24 were rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1 to 4 of U.S. Patent No. 6,377,610 ("the '610 patent"). That rejection is obviated by the concurrent filing herewith of a terminal disclaimer (along with the appropriate fee). Accordingly, withdrawal of the rejection of claims 1 to 24 under the double patenting rejection is respectfully requested. Applicants respectfully submit that claims 1 to 24 are in condition for allowance.

Claims 1 to 24 were rejected under 35 U.S.C. § 103(a) as unpatentable over "Forward Error Correcting for CDMA Systems," by Joachim Hagenauer (the "Hagenauer I reference") in view of any disclosed art of the present application and further in view of "Iterative Decoding of Binary Block and Convolutional Codes," by Joachim Hagenauer (the "Hagenauer II reference").

The Hagenauer I reference purportedly concerns a CDMA/FEC system in which a soft-in/soft-out decoder which transfers a soft decision from the inner to the outer decoder is used. See Abstract, Hagenauer I reference.

Claims 1 and 17 are the only independent claims. Rewritten claim 1 recites a decoding method for demodulating a received signal available in serial code concatenation in a code-division multiple access transmission system, a two-step code being carried out at the transmitting end of the transmission system, including:

> providing a soft-in/soft-out decoder in a receiver of the transmission system, a first decoder step of the soft-in/soft-out decoder including an inner decoder and a Hadamard orthogonal multi-step inner code, a second decoder step of the soft-in/soft-out decoder including an outer decoder and an outer error correcting code of a predefined rate; and
>
> processing soft values as reliability information at an output and an input of the soft-in/soft-out decoder, a soft output of the inner decoder being a soft input for the outer decoder, a channel reliability information output from a preceding demodulation being an input for the inner decoder.

The Hagenauer I reference is not believed to disclose providing a <u>two</u>-step decoding method including a soft-in/soft-out decoder provided in a receiver of a transmission system where a <u>first</u> decoder step includes an inner decoder and a Hadamard orthogonal multi-step inner code and a <u>second</u> decoder step includes an outer decoder and an outer error correcting code of a predefined rate. Further, the Hagenauer I reference is not believed to disclose that the soft values are processed as reliability information at the output and input of the soft-in/soft-out decoder, where a channel reliability information output from a preceding demodulation is a input for the inner decoder.

The Hagenauer II reference purportedly concerns iterative decoding of two-dimensional convolutional codes, termed "turbo (de)coding," where a decoder which accepts soft inputs, including a priori inputs, apparently may be used to deliver soft outputs. See Abstract, Hagenauer II reference. The Hagenauer II reference appears to consider some algorithms which have the property that extrinsic information is used as a priori information in a next iteration step -- though the Hagenauer II reference indicates that satisfying analytic results are not yet available. See Introduction, Hagenauer II reference.

The Hagenauer II reference does not cure the deficiencies of the Hagenauer I reference. The Hagenauer II reference also does not appear to disclose providing a two-step decoding method including a soft-in/soft-out decoder provided in a receiver of a transmission system where a first decoder step includes an inner decoder and a Hadamard orthogonal multi-step inner code and a second decoder step includes an outer decoder and an outer error correcting code of a predefined rate. And, the Hagenauer II reference is not believed to disclose that the soft values are processed as reliability information at the output and input of the soft-in/soft-out decoder, where a channel reliability information output from a preceding demodulation is a input for the inner decoder. And, with respect to the Office Action's reference to "critical element," the Hagenauer II reference is merely cited in the Hagenauer I reference with respect to "suboptimal solutions" of soft-in/soft-out decoders with a priori information. Accordingly, Applicants respectfully submit that rewritten claim 1 is allowable over all of the cited art, taken alone or in combination. Withdrawal of the rejection under 35 U.S.C. § 103(a) is respectfully requested and allowance of claim 1 is respectfully requested.

Claim 17 recites features analogous to those of claim 1. Accordingly, it is respectfully submitted that claim 17 is allowable for essentially the same reasons as for claim 1.

Since the remaining claims 2 to 16 and 18 to 24 depend from one of claim 1 and claim 17, those dependent claims are allowable for at least essentially the same reasons as for claim 1.

CONCLUSION

In view of all of the above, it is believed that the objection to claims 1 and 17, and the rejection of claims 1 to 24 and 24 have been obviated. Accordingly, it is respectfully submitted that all claims 1 to 24 are allowable.

It is therefore respectfully requested that the objections and rejections be reconsidered and withdrawn, and that the present application issue as early as possible. The

Examiner is encouraged to contact the undersigned attorney if such contact would further allowance of the present application.

Respectfully submitted, (By: Linda M Studley Reg. No. 47,084)

Dated: May 14, 2003

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AMENDED VERSION SHOWING CHANGES MADE

IN THE CLAIMS:

Please amend without prejudice claims 1, 10 to 15 and 17, as follows:

1. (Amended) A decoding method for demodulating a received signal available in serial code concatenation in a code-division multiple access transmission system, a two-step coding being carried out at the transmitting end of the transmission system, [a first step of the two-step coding including a Hadamard orthogonal multi-step inner code, a second step of the two-step coding including an outer error-correcting code of a predefined rate,] the method comprising:

providing a soft-in/soft-out decoder in a receiver of the transmission system, a first decoder step of the soft-in/soft-out decoder including an inner decoder and a Hadamard orthogonal multi-step inner code, a second decoder step of the soft-in/soft-out decoder including an outer decoder and an outer error correcting code of a predefined rate; and

processing soft values as reliability information at an output and an input of the soft-in/soft-out decoder, a soft output of the inner decoder being a soft input for the outer decoder, a channel reliability information output from a preceding demodulation being an input for the inner decoder.

10. (Amended) The method as recited in claim 7 wherein the inner decoder includes a maximum a-posteriori decoder and wherein the a-priori information is made available to the inner decoder as reliability values in an a-priori vector L(u), u being a bit, so that the inner decoder provides L-values for estimated symbols of an inner decoder soft value output vector L(û), an amount $|L(\hat{u}_k)|$ of the L-values indicating a reliability of a respective decision and an operational sign of the $L(\hat{u}_k)$ representing a hard decision.

11. (Amended) The method as recited in claim 9 wherein the inner decoder includes a maximum a-posteriori decoder and wherein the a-priori information is made available to the inner decoder as reliability values in an a-priori vector L(u), u being a bit, so that the inner decoder provides L-values for estimated symbols of an inner decoder soft value output vector

$L(\hat{u})$, an amount $|L(\hat{u}_k)|$ of the L-values indicating a reliability of a respective decision and an operational sign of the $L(\hat{u}_k)$ representing a hard decision.

12. (Amended) The method as recited in claim 1 wherein the receiver includes a coherent receiver structure, wherein a soft input of the inner decoder includes a-priori information for systematic bits of Walsh functions of the inner code and wherein the inner decoder includes a maximum a-posteriori decoder, the maximum a-posteriori decoder calculating, starting from an input vector $L_C \cdot y$, y being a vector, having a specific reliability L_C and from an a-priori information vector L(u), u being a bit, as a decoder result, a weighted decision including reliability L-values for estimated symbols, the L-values including an extrinsic term $L_e(\hat{u}_k)$.

13. (Amended) The method as recited in claim 1 wherein the receiver includes a coherent receiver structure, wherein a soft input of the inner decoder includes a-priori information for systematic bits of Walsh functions of the inner code, and wherein the inner code includes a Hadamard code, the Hadamard code being decoded by:

adding an a-priori information vector L(u), u being a bit, for systematic bits of a Walsh function of the Hadamard code to an input vector $L_C \cdot y$, y being a vector, from a channel;

performing a fast Hadamard transformation so as to provide a fast Hadamard transform resultant vector w;

then generating exponential functions with $\frac{1}{2} \cdot w_j$ as an argument, w_j being a respective element of the vector w; and

adding, dividing and expressing logarithmically elements of a result vector z for each symbol $\hat{u}_K$ to be decoded according to the equation:

Term 1 Term 2

$$\ln \frac{\sum_{j,u_k=+1}^{N-1} z_j}{\sum_{j,u_k=-1}^{N-1} z_j} = \ln \frac{\sum_{j,u_k=+1}^{N-1} \exp(\frac{1}{2} w_j)}{\sum_{j,u_k=-1}^{N-1} \exp(\frac{1}{2} w_j)} = \ln\left(\sum_{j,u_k=+1}^{N-1} \exp(\frac{1}{2} w_j) \right) - \ln\left(\sum_{j,u_k=-1}^{N-1} \exp(\frac{1}{2} w_j) \right)$$

z_j being a respective element of the resultant vector z, j being a respective vector element index, N being a size of the Walsh functions of the inner code.

14. (Amended) The method as recited in claim 1 wherein a result of the inner decoder for a bit $\hat{u}_k$ includes a-priori information $L(u_k)$, u being a bit, about a bit to be decoded, channel information $L_C \cdot y_{sys(k)}$ about the bit to be decoded, and extrinsic information $L_e(\hat{u}_k)$, channel information and a-priori information on all other bits of a demodulator output vector y or of a transmitted Walsh function of the inner code being included in the extrinsic information $L_e(\hat{u}_k)$.

15. (Amended) The method as recited in claim 1 wherein the receiver includes an incoherent receiver structure and wherein the inner decoder includes a maximum a-posteriori decoder, the maximum a-posteriori decoder calculating, starting from a square-law-combining fast Hadamard transform resultant decision vector w and from an a-priori vector L(u), u being a bit, as a decoder result, a weighted decision including the L-values for estimated symbols, the L-values including an extrinsic term $L_e(\hat{u}_k)$.

17. (Amended) A decoding device for demodulating a received signal available in serial code concatenation in a code-division multiple access transmission system, a two-step coding being carried out at the transmitting end of the transmission system, [a first step of the two-step coding including a Hadamard orthogonal multi-step inner code, a second step of the two-step coding including an outer error-correcting code of a predefined rate,] the device comprising:

a soft-in/soft-out decoder disposed in a receiver of the transmission system, a first decoder step of the soft-in/soft-out decoder including an inner decoder and a Hadamard orthogonal multi-step inner code, a second decoder step of the soft-in/soft-out decoder including an outer decoder and an outer error-correctinge code of a predefined rate, soft values being processed as reliability information at an output and an input of the soft-in/soft-out decoder, a soft output of the inner decoder being a soft input for the outer decoder, a channel reliability information output from a preceding demodulation being an input for the inner decoder.